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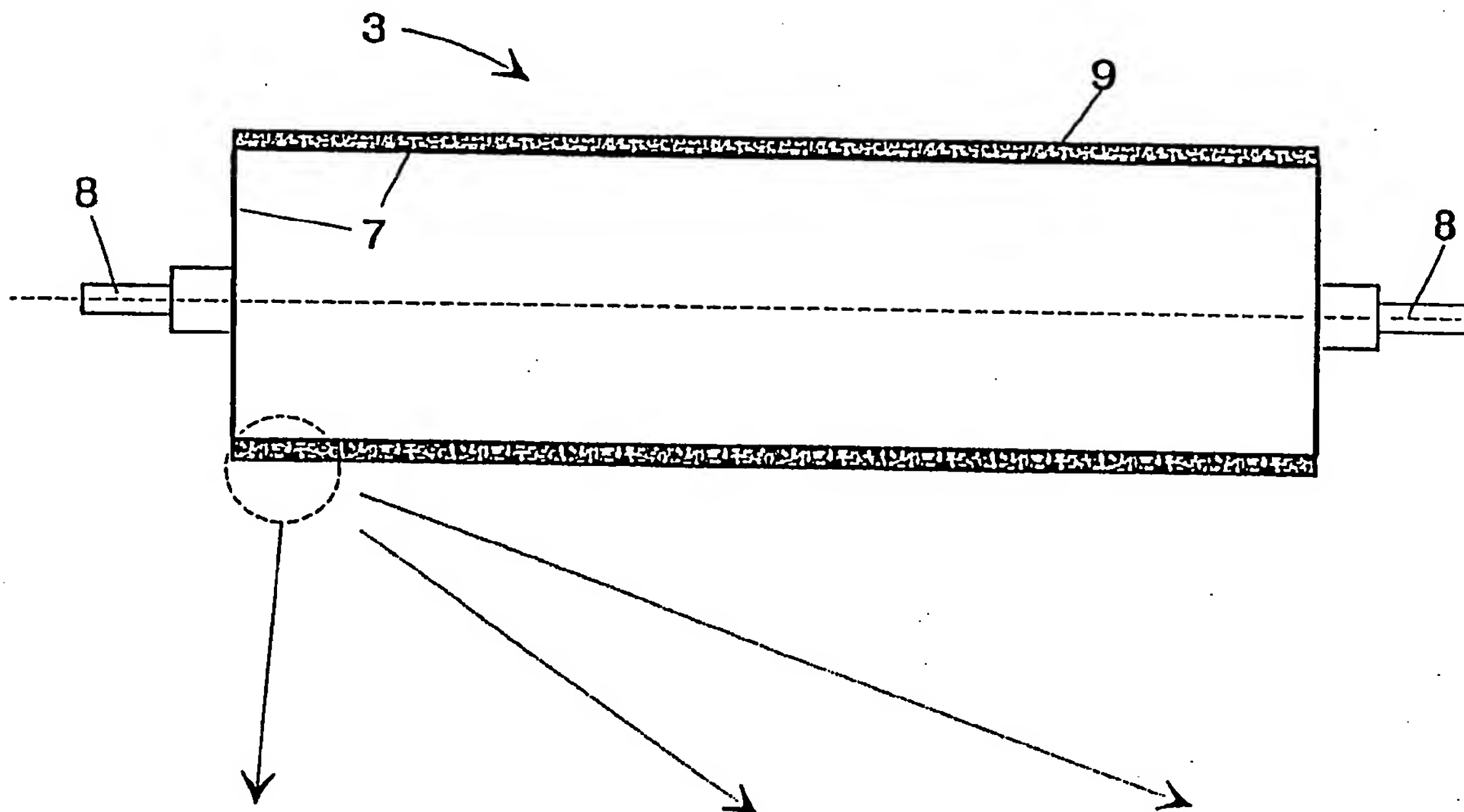
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(54) Title: ROLLER FOR A WINDING MACHINE



(57) Abrégé/Abstract:

It is known that in order to wind up webs (1) of paper or cardboard it is possible to use winding machines with rollers that have a hollow, cylindrical support body (7) that is of rigid material, with a deformable layer applied to its outside surface. The deformable layer (9) is of a cellular plastic material that incorporates a large number of evenly distributed pores, the size of which is smaller than 5 mm, and is preferably between 0.05 and 1 mm. The pores include partially open pores and closed pores. The compression modulus  $k$  is less than 10 MPa. It is preferred that the roller according to the present invention be used in the winding machine as a carrier roller (5) or a pressure roller (6).



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Abstract

It is known that in order to wind up webs (1) of paper or cardboard it is possible to use winding machines with rollers that have a hollow, cylindrical support body (7) that is of rigid material, with a deformable layer applied to its outside surface. The deformable layer (9) is of a cellular plastic material that incorporates a large number of evenly distributed pores, the size of which is smaller than 5 mm, and is preferably between 0.05 and 1 mm. The pores include partially open pores and closed pores. The compression modulus  $k$  is less than 10 MPa. It is preferred that the roller according to the present invention be used in the winding machine as a carrier roller (5) or a pressure roller (6).

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It is the object of the present invention to create a roller for a winding machine such that when said roller is used as a carrier or support roller it is possible to wind up material without any winding faults, at lesser winding hardness. When used as a pressure roller it is intended to even out variations in the uniformity of the takeup rolls, which result, for example, from variations in the profile of the web, so as to ensure the uniformity of the contact pressure.

10

#### Technical domain

The present invention relates to a carrier, support, or pressure roller for a winding machine, in particular a roller that is used to wind up paper or cardboard webs, this being intended to lie against the takeup rolls under pressure during the winding process, and a winding machine with a roller according to the present invention.

20

#### Prior Art

It is already known that in order to produce takeup rolls from webs of paper or cardboard that have been divided by a longitudinal cut, winding machines are used that incorporate one or two powered rollers on which the takeup rolls lie during the winding-on process. The rollers are referred to as carrier rollers in the event that they bear the complete weight of the takeup rolls that are lying upon them

(DE-A 39 24 612). In the event that the weight is supported totally or in part by guide heads that are introduced into the sleeves of the winding rollers and supported on carrier arms, then the rollers are referred to as support rollers (DE-C 31 02 894, DE-C 40 12 979).

10 Furthermore, winding machines also contain a so-called pressure roller that is pressed against the takeup rolls, opposite to the line of contact between a takeup roller and a support or carrier roll, at the beginning of the winding-on process, if the contact pressure that is generated by the weight of the roll is still insufficient to achieve the desired hardness of the roll of web that is being formed (DE-C 37 19 093, EP-C 0410093), which makes a considerable contribution to the stability of the winding process.

20 The hardness of the wound-up roll (= stress per unit area between the layers of a takeup roll) that is critical for the quality of the roll of product is a function of the linear load and the geometric conditions in the nip between a takeup roll and the carrier or support roller. The linear load is defined as the contact pressure that is standardized across the width of the takeup roll, measured in N/m. When takeup rolls are produced, every effort is made to set up a predetermined, even roll hardness at high production speeds, and to do so without causing any surface imperfections or winding faults in the takeup roll. Faults in the wound-up roll are caused by overextension of the web in the nip. Since the extension in the nip between a roller and a takeup roll increases as the diameter of the roll increases, its value

limits the final diameter of a roll that has been wound up without any faults.

10 In order to produce takup rolls of large diameter and of good winding quality, EP-A 0562266 proposes a carrier-roller winding machine in which the exit end support roller, which is not wrapped around by the web and which is lowered relative to the entry end support roller, has a covering that can be deformed significantly more than the covering of the entry end support roller. According to one embodiment, the carrier roller has an outer layer that is of rubber, in which there are chambers that are connected to the interior of the support body that is of steel. Because of the great deformability, the contact pressure on the support rolls is limited as much as possible, so that the hardness of the takeup roll does not increase to an unusually high level.

20 US Patent 3,503,567 describes a winding machine that is used to wind up paper; this is coated with pressure sensitive capsules. In order to prevent the pressure sensitive capsules from being squashed in the nip between the takeup roll and the support roller, the support roller comprises a support body of metal, to the outer surface of which a deformable layer of a foamed, synthetic material is applied. The deformable layer of the support roller absorbs such a large proportion of the pressure between the takeup roll and the support roller that the capsules are preserved from being squashed.

#### Description of the invention

It is the object of the present invention to create

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a roller for a winding machine, which when used as a carrier roller or support roller makes it possible to produce a takeup roll that is of lesser hardness. When it is used as a pressure roller, it is intended to even out variations in the uniformity of the takeup rolls when such unevenness results from variations in the profile of the web, so as to ensure the uniformity of the contact pressure.

The invention provides: a roller for a winding machine for winding paper or cardboard webs into rolls, said roller comprising: a hollow cylindrical support body made of a rigid material; and a deformable layer on the outer cylindrical surface of said body and consisting of cellular plastic material with a multitude of uniformly distributed pores and of a compression modulus  $k$  of less than 10 MPa, said pores including a proportion of open pores and a proportion of closed pores.

#### Brief description of the drawings

The present invention will be described in greater detail below on the basis of the drawings appended hereto. The drawings show the following, in simplified form:

Figure 1: A longitudinal cross section through a carrier or support roller according to the present invention;

Figure 2: A cross section through the roller as in Figure 1;

Figures 3 to 5: Different versions of the external covering of the roller;

Figure 6: A roller in which the compressible layer is made of individually installed rings;

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Figures 7 and 8: The action of a carrier roller according to the present invention, as compared to a carrier roller according to the prior art, as used in a carrier-roller winding machine.

5

Ways to realize the present invention

Figure 8 shows the principle of a carrier-roller winding machine that is used to wind up webs 1 of paper or cardboard that have been divided by a longitudinal cut on to takeup rolls 2, in which the rollers shown in Figures 1 to 6  
10 can be used as carrier rollers or pressure rollers. A carrier-roller winding machine has two powered carrier rollers 3, 4, on which the takeup rolls 2 lie coaxially so as to be aligned, and these support the whole weight of the takeup rolls during the winding-on process. It is preferred  
15 that the web 1 of paper or cardboard be routed from below so as to wrap part way round the entry-end carrier roller 4, through the gap between the carrier rollers 3, 4, and enter the nip between the entry-end carrier roller 4 and the takeup rolls 2.

20

One or both the carrier rollers 3, 4 of the carrier-roller winding machine are configured as rollers according to the present invention. It is preferred that the roller according to the present invention be used as carrier roller 3 that is arranged opposite the entry-end  
25 carrier roller 4 in such a way that its line of contact with the takeup roll (nip 5) is at the same level as or lower than the line of contact between the other carrier roller 4 and the takeup roll. The carrier roller 3 thus supports the same proportion--or a greater one--of the weight of the  
30 takeup roll 2. In addition, the entry-end carrier roller 4 can be configured as a roller according to the present invention.



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Above, a pressure roller 6 that extends across the whole working width of the winding machine, i.e., the axial length of the carrier rollers 3, 4, lies on the takeup rolls 2; at the beginning of the winding-on process, this presses



the takeup rolls 2 against the carrier rolls 3, 4 if the weight of the takeup rolls is not yet sufficient to achieve the desired hardness of the takeup roll.

Figures 1 to 6 show in detail the construction of the roller according to the present invention when it is used as a carrier roller or support roller 3. As a carrier or support roller 3 it is of an axial length that matches the maximum width of the web 1 of paper or cardboard that is to be processed, this may amount to as much as 10 m, and its diameter may be between 500 mm and 1500 mm. The carrier roller or support roller 3 according to the present invention comprises a hollow, cylindrical support body 7 that is made of a rigid material, in particular of steel, that is designed so as to be sufficiently strong that it can support the forces acting through the takeup roll, which rests on or against it, without flexing. Shaft journals 8, by which the shaft 3 is mounted in the frame of the winding machine, are secured to both end faces of the supporting body 7. One shaft journal 8 of each carrier roller or supporting roller 3 is connected to a rotary drive system, by which the roller 8 is caused to rotate about its longitudinal axis in order to turn the takeup rolls that lie on or against the carrier rollers or support rollers, in order to wind on the web.

A layer 9 of a plastic cellular material that incorporates a plurality of pores filled with a gas, in particular air, and which, for this reason, is compressible, is applied to the outer surface of the supporting body 7. This has a compression modulus  $k$  of less than 10 Mpa. It is

important that a large number of relatively small pores is distributed evenly throughout the volume of the layer 9. It is preferred that the pore size be smaller than 5 mm; a pore size between 0.05 mm and 1 mm has been found to be particularly advantageous. It is also preferred that some of the pores in the layer 9 be open, which is to say connected to each other, and that some are closed. The proportion of open pores is 30 per cent to 70 per cent, preferably approximately 50 per cent. The ratio of open pores to closed pores  
10 determines both the compressibility of the layer as well as its ability to dissipate the heat that is generated within it, in order to avoid any undesirable overheating.

It is preferred that a cellular elastomer, particularly polyurethane, produced by foaming, be used for the layer 9, this having a compressibility modulus  $\kappa$  of 1 Mpa to 5 Mpa. The thickness of the layer 9, as measured radially, amounts to at least 10 mm, and is preferably between 10 mm and 40 mm. In the example, it is 25 mm thick. The density of the material used for the layer 9 with the pores is less than 800  
20 kg/m<sup>3</sup>, and is preferably between 350 and 650 kg/m<sup>3</sup>. According to one preferred embodiment, the layer 9 is of a hardness between 15 and 60 as measured according to Shore-A. Thus the roller is relatively soft on its outer surface, so that it forms a relatively wide nip when it lies against a takeup roll.

Figures 3 to 5 show various ways in which the compressible layer 9 can be arranged on the supporting body 7.

In the embodiment that is shown in Figure 3 there is

just a layer 9 of compressible material on the outside surface of the supporting body 7. It is preferred that this material be a cellular elastomer. The layer 9 is 10 to 40 mm thick.

Within the outer surface of the layer 9 there is a plurality of circular grooves (not shown in the drawing) that are machined into the layer in order to avoid air being trapped in a takeup roll 2 or to prevent the generation of excessive noise during the winding-on process.

10 In the embodiment shown in Figure 4, between the compressible layer 9 and the supporting body 7 there is a hard base layer 10 of non-compressible material, preferably rubber, that is bonded securely to the supporting body 7. This slip-proof bond can be achieved by vulcanizing. In order to form a wear-resistant outer running surface 11, an additional elastic layer is secured to the compressible layer 9, on the outside. If necessary, this additional layer can also be grooved.

20 Figure 5 shows an embodiment with circular grooves 12 in a wear-resistant outer layer 11. The compressible layer 9 is secured directly to the supporting body 7 without any intermediate layer.

In the embodiments that are shown in Figures 4 and 5, which have an additional elastic, albeit non-compressible, layer 11, it is critical that their structure and properties be so selected that, used as purely protective layers, they do not significantly affect the deformability, particularly the compressibility of the outside surface of the carrier roller or supporting roller 3 when it is under the load of a takeup roll 2. In order to reduce their effect on this

deformability, the outer running layer 11 can be weakened by cuts that are made in it transversely to the grooves 12.

Figure 6 shows the preferred embodiment of a carrier roller or support roller according to the present invention, in which the compressible layer 9 is made up of separate, individual rings 13. The rings 13, 50 mm to 500 mm wide in the axial direction of the roller, are arranged directly adjacent to each other or else spaced apart by a small distance such that the gap between any two rings does not cause any marking on the takeup roll 2. In the event that there is a space between the rings 13, it is preferred that this amount to 5 mm to 30 mm. It is preferred that rings 13 be used that have an outside diameter that is greater than the outside diameter of the supporting body 7 by the thickness of the layer 9, and an inside diameter is somewhat smaller than the outside diameter of the supporting body 7. The rings 13 are slid onto the supporting body 7 one after the other, with their inside diameters extended by stretching, so that in the end they are installed on the supporting body 7 under tension. This tension ensures a slip-free installation of the rings 13 on the supporting body 7. A sufficiently tight fit can also be achieved in that the rings are secured to the supporting body by shape-mating, by being cemented onto it, or by being forced onto it. The rings are arranged on the supporting body, parallel to each other, such that their end face surfaces are either perpendicular to the axis of the roller, or are inclined relative to it. In the second version, the rings form a quasi-helical line, which entails the advantage

that a gap between the rings 13 constantly varies its axial position, so that the surface of the takeup roll is not marked.

Another possibility for applying the compressible layer 9 to the support body 7 is to wind a strip of compressible material onto the supporting body 7 in a helical coil. Non-slip installation of the layer 9 can be achieved by using any of the methods referred to above, e.g., by winding on the material when it is under tension. The roller then comprises a supporting body 7 with a compressible layer 9 that is in the form of a strip of compressible material that is applied as a helical winding.

The advantageous effect of a carrier roller or support roller 3 vis-à-vis known carrier rollers or support rollers 14 with an elastic albeit non-compressible outer surface (e.g., of pure rubber) is explained in Figures 7 and 8.

Figure 7 shows a carrier-roller winding machine as in the prior art, in which the exit-end carrier roller 14 has a flexible albeit non-compressible outer surface. Under the load imposed by the weight of the takeup roll 2, the carrier roller 14 deforms elastically in the nip 5. The expressed elastic material forms beads 15 at each end of the nip 5, and these extend radially relative to the remainder of the outside surface. The beads 15 at the nip 5, which has a significant effect on the hardness of the takeup roll, increase the effective radius of the carrier roller 14, so that the outermost layer of the takeup roll 2 is accelerated in this

area. This acceleration increases the so-called nip-induced elongation of the outer layer, i.e., the hardness of the takeup roll increases. The positive effect intended by the elastic outer layer, which is to decrease the contact pressure and thus the hardness of the takeup roll that is a function of the contact pressure, is correspondingly reduced, and may even be reversed.

Figure 8 shows the conditions when winding on with a carrier-roller winding machine using the carrier roller 3 according to the present invention.

Under the weight of the takeup rolls 2, the compressible layer 9 is compressed and its volume is reduced. This results in a wide nip 5 without any beads, or with insignificantly smaller beads at both ends. The contact pressure on the carrier roller 3 is reduced because of the wider nip 5, and the nip-induced elongation of the outermost layer on the takeup roll 2 is reduced. Compared to the known winding machines, given equal contact weight per meter of roller length, it is possible to complete the winding operation to produce takeup rolls that are not so hard. This makes it possible to wind up takeup rolls of greater final diameter, and to do so without any damage being done to the webs of paper or cardboard, and without any winding faults in the takeup roll 2.

The use of a roller according to the present invention is not restricted to use as a carrier roller in carrier-roller winding machines; it can also be used to advantage in other types of winding machines, other than as a



contact roller that lies under pressure against takeup rolls, in order to produce takeup rolls of large diameter, of high quality, at high production speeds. In particular, it can be used as a support roller in so-called support roller winding machines, in which winding stations are arranged in two lines on both sides of a central support-roller winding machine, to which the individual webs are routed in alternation. Each takeup roll is held by two guide heads that are supported in winding stands of the winding stations--as described, for example, in DE-PS 36 29 024--that support part of the weight of the takeup roll. The remainder is supported by the central support roller against which each takeup roll rests.

When used as a pressure roller, which is numbered 6 in Figures 7 and 8, given a short axial length the roller is constructed in the manner described heretofore for Figures 1 to 6. Since pressure rollers are supported so as to be able to rotate freely, and are not driven, no drive system is connected to the roller journals 8. In the case of pressure rollers that are of longer axial length, as are used, for example, in carrier-roller winding machines, it is preferred that the pressure roller be made up of single, rotatably supported segments in order that each segment can rotate independently. Pressure rollers can be of diameters that range from 200 to 400 mm, and are usually of smaller diameters than carrier rollers or support rollers.



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CLAIMS:

1. A roller for a winding machine for winding paper or cardboard webs into rolls, said roller comprising: a hollow cylindrical support body made of a rigid material;  
5 and a deformable layer on the outer cylindrical surface of said body and consisting of cellular plastic material with a multitude of uniformly distributed pores and of a compression modulus  $k$  of less than 10 MPa, said pores including a proportion of open pores and a proportion of  
10 closed pores.
2. The roller defined in claim 1 wherein the layer consists of a cellular elastomer particularly polyurethane, with a compression modulus between 1 MPa and 5 MPa.
3. The roller defined in claim 2 wherein the layer  
15 consists of polyurethane.
4. The roller defined in any one of claims 1 to 3 wherein the size of the pores is less than 5 mm.
5. The roller defined in claim 4 wherein the size of the pores is between 0.05 mm and 1 mm.
- 20 6. The roller defined in any one of claims 1 to 5 wherein the proportion of open pores is 30% to 70%.
7. The roller defined in claim 6 wherein the proportion of open pores is about 50%.
8. The roller defined in any one of claims 1 to 6  
25 wherein the layer has a hardness of between 15 and 60 Shore A.
9. The roller defined in any one of claims 1 to 6 wherein the thickness of the layer is at least 10 mm.

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10. The roller defined in claim 9 wherein the thickness of the layer is between 10 mm and 40 mm.

11. The roller defined in any one of claims 1 to 9 wherein a wear-resistant elastic running layer is applied to  
5 an outside of the deformable layer.

12. The roller defined in claim 11 wherein the elastic running layer has grooves.

13. The roller defined in any one of claims 1 to 12 wherein between the deformable layer and the support body is  
10 arranged a hard base layer which consists of an incompressible material and which is connected to the support body in a non-slip manner.

14. The roller defined in any one of claims 1 to 13 wherein the deformable layer is composed of individual  
15 rings.

15. The roller defined in claim 14 wherein the rings are arranged at a distance of 5 mm to 50 mm from one another.

16. The roller defined in claim 14 wherein end faces  
20 of the rings run obliquely to a roller axis.

17. The roller defined in any one of claims 1 to 13 wherein the deformable layer consists of a helically applied tape-like material.

18. A winding machine for winding paper or cardboard  
25 webs into rolls, comprising at least one supporting or pressing roller, said roller comprising: a hollow cylindrical support body made of a rigid material; and a deformable layer on the outer cylindrical surface of said body and consisting of cellular plastic material with a

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multitude of uniformly distributed pores and of a compression modulus  $k$  of less than 10 MPa, said pores including open pores and closed pores.

19.       The winding machine according to claim 18 with two  
5 supporting rollers carrying the weight of the winding roll,  
with one of the two carrying rollers being arranged in such  
a way that a line of contact with the rolls is lower than  
the line of contact of the other supporting roller, at least  
the supporting roller with the lower line of contact having  
10 said layer.

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PATENT AGENTS

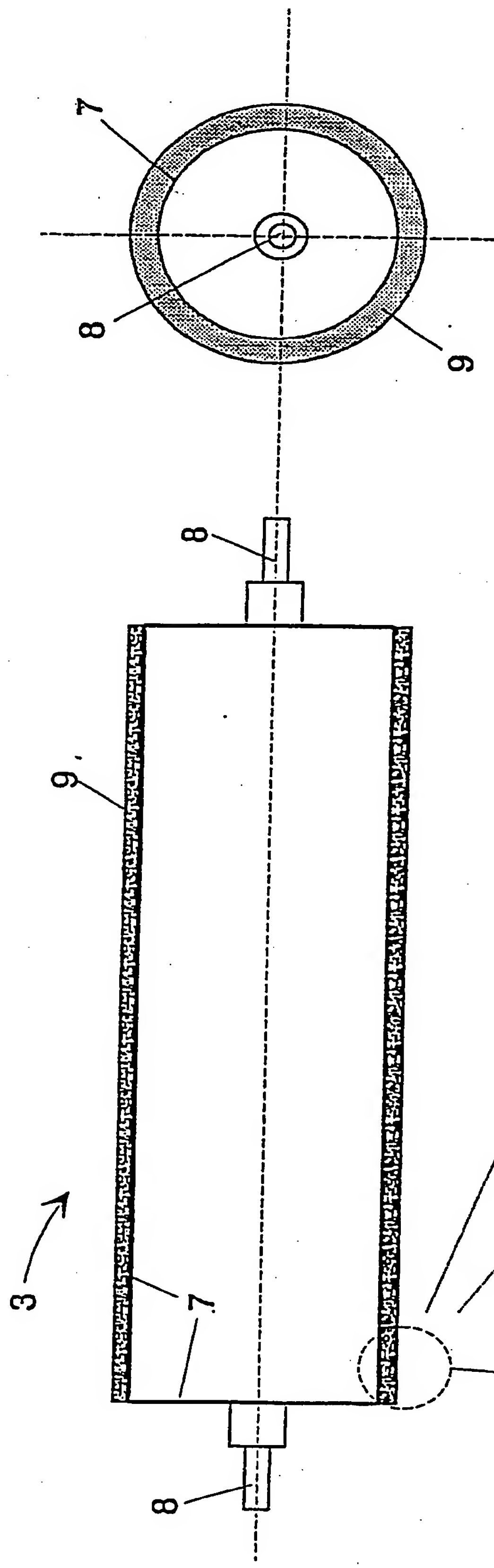


Fig. 1

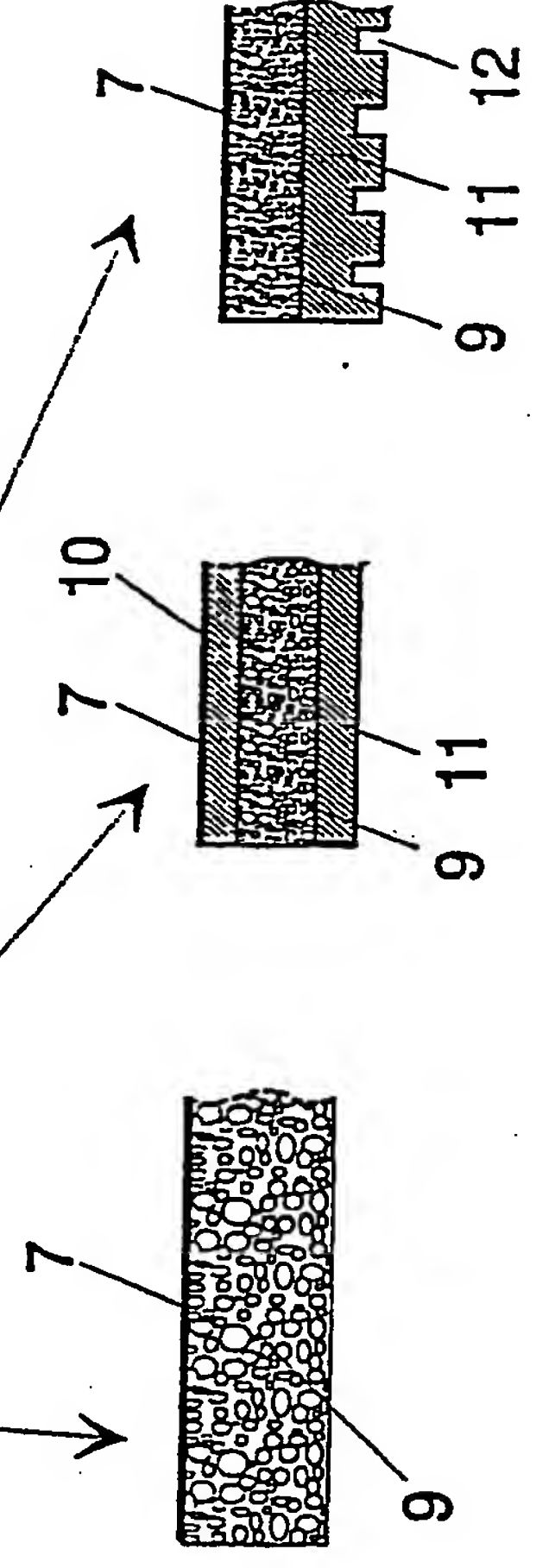


Fig. 3

Fig. 4

Fig. 5

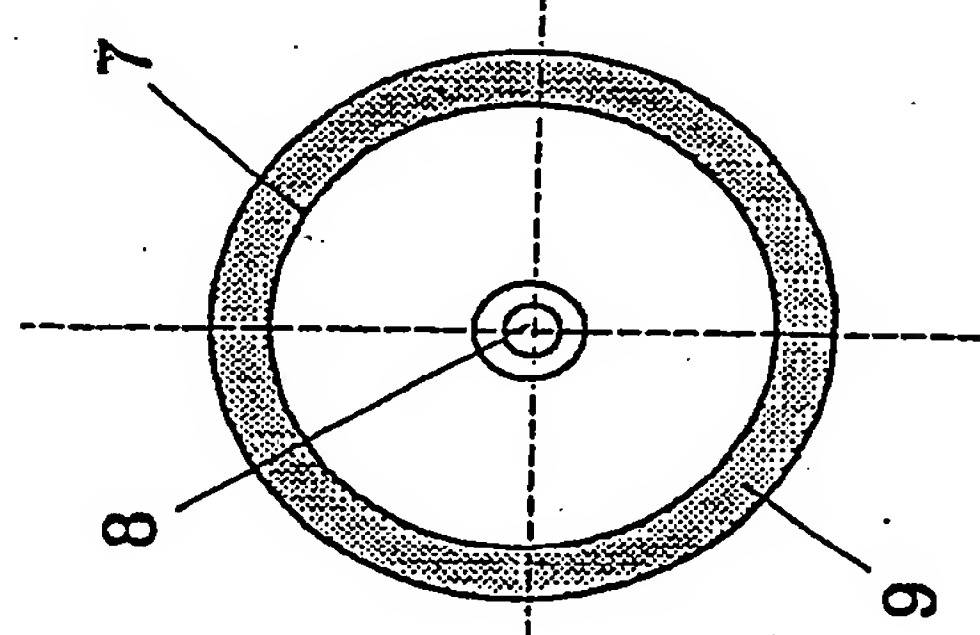


Fig. 2

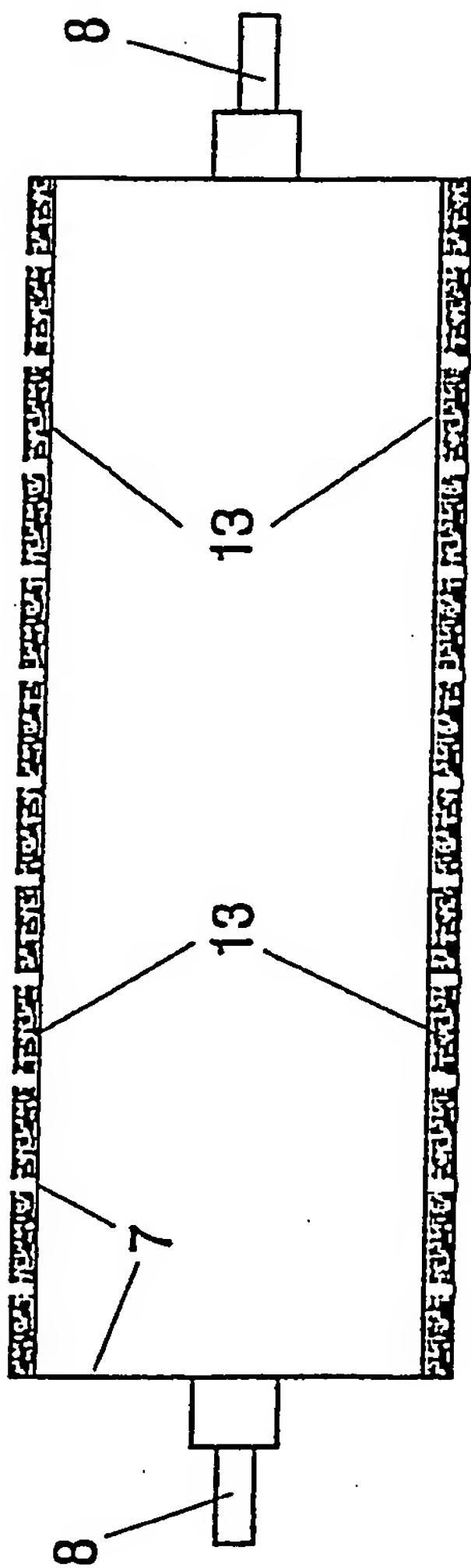


Fig. 6

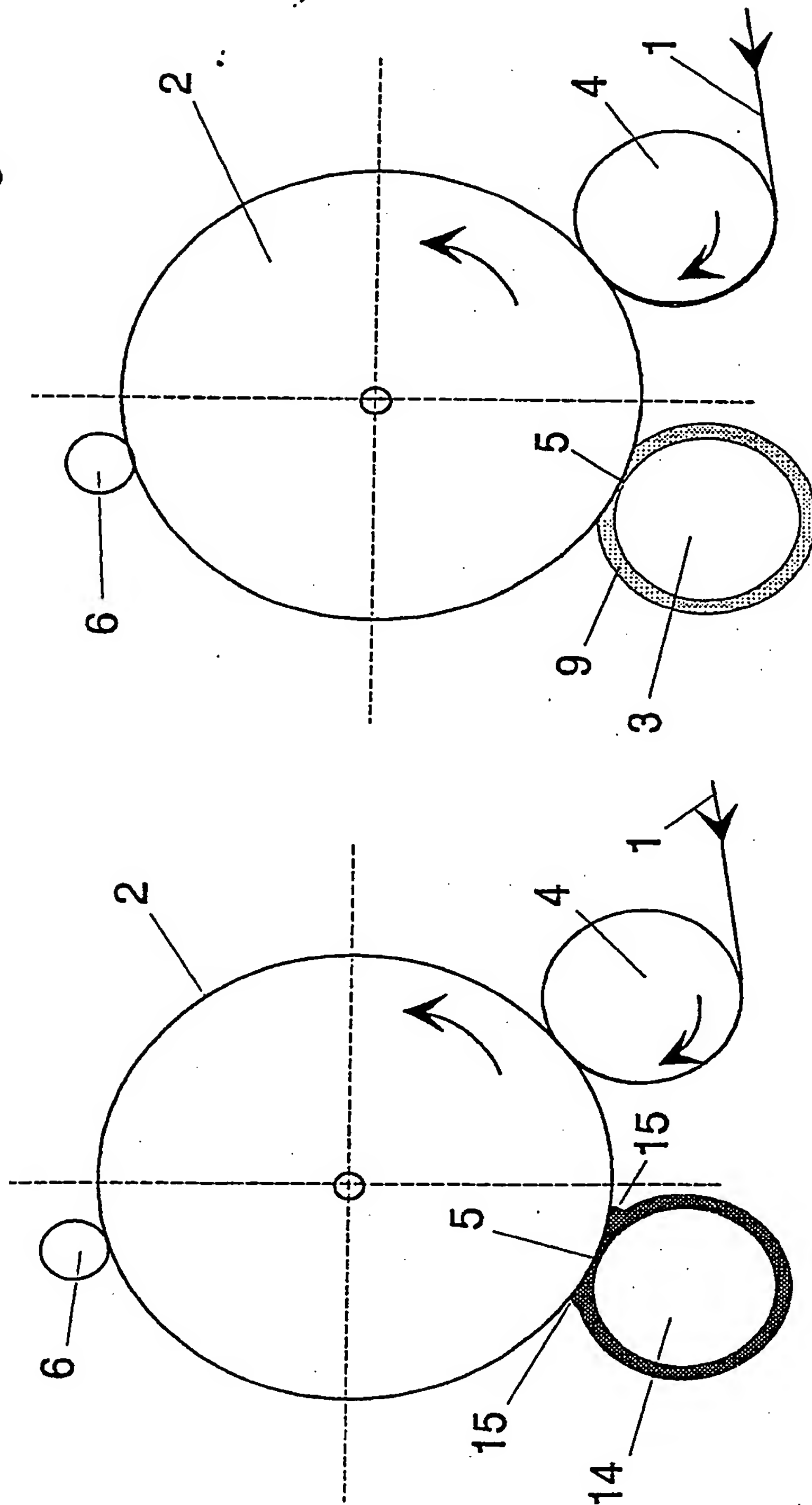


Fig. 7

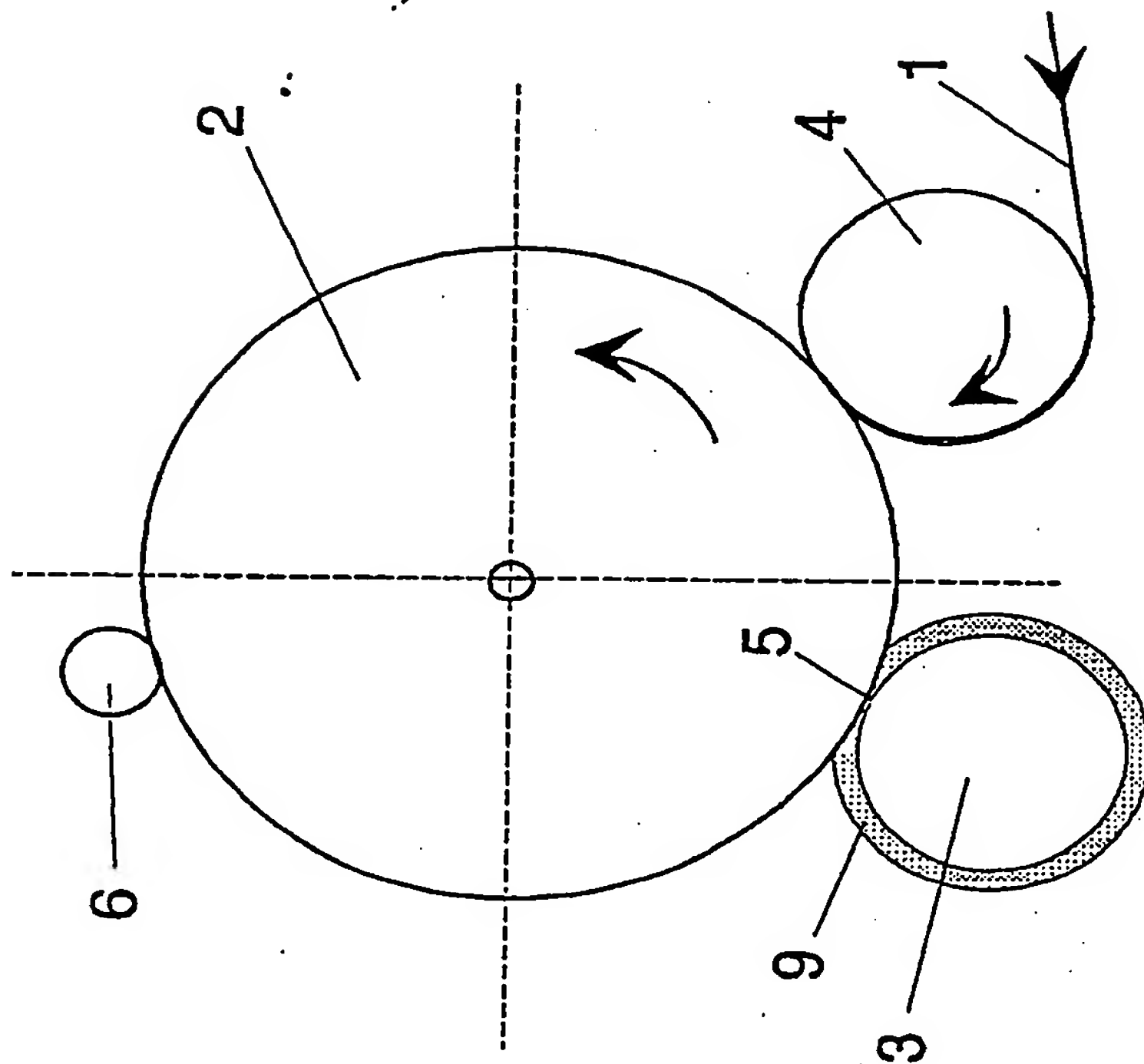


Fig. 8

